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Winds of Change: How Wind and Solar Will Affect the Front Range

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Winds of Change: How Wind and Solar Will Affect the Front Range

Abstract:

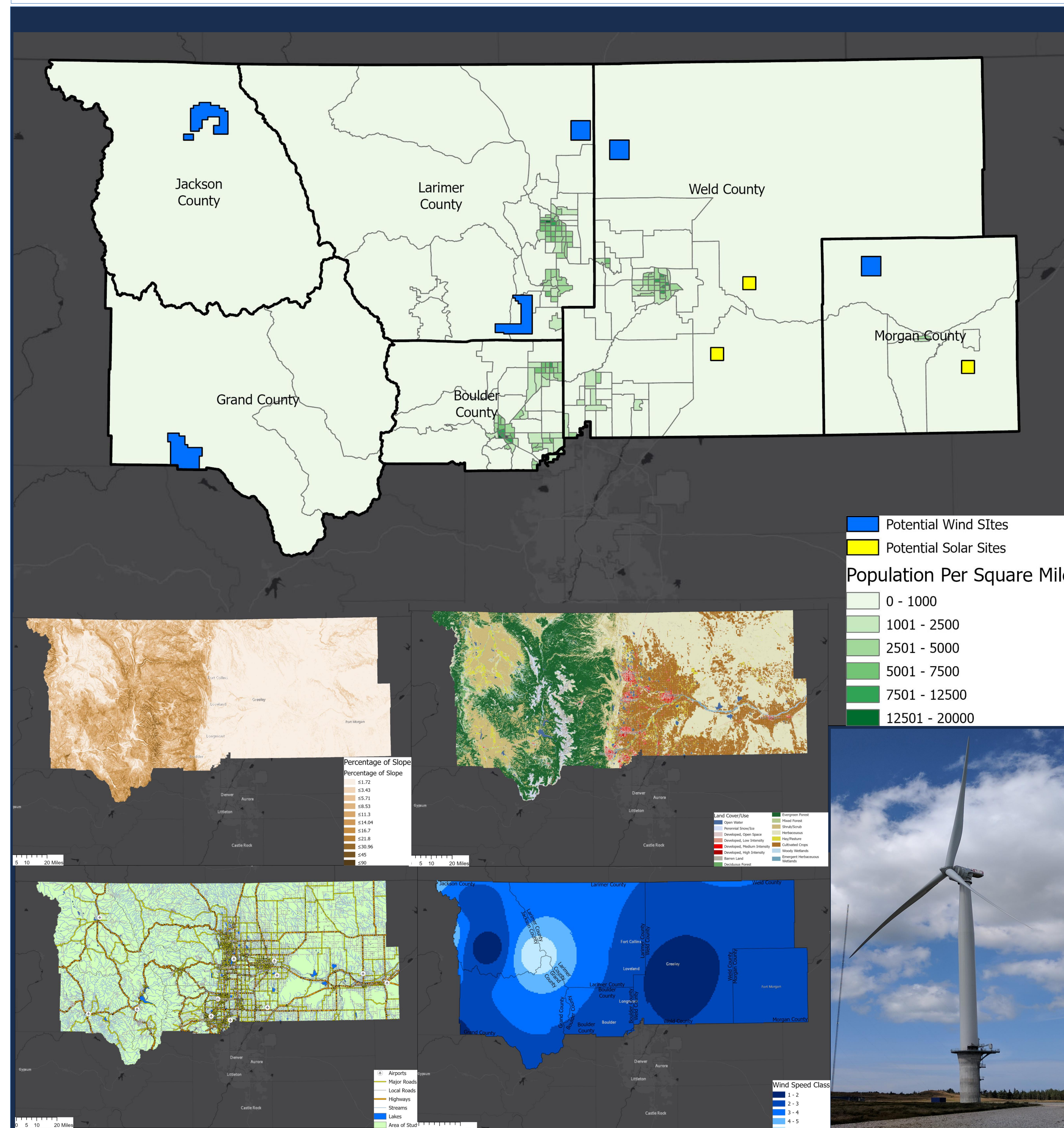
In May of 2019 Governor Jared Polis announced Colorado would be Carbon Neutral by 2040. This is an effort by the state government to drive innovation and reduce costs to consumers while also leading in the transition to clean energy. This will help reduce air pollution and curtail the effects of climate change. As of a massive undertaking, the most complicated part of this plan will be to identify the energy sources of the state's electricity. In 2019 the state produced 29.7 trillion kWh of energy and only 3.3 trillion kWh were made from renewable sources. This deficit means there is lots of room for growth in the renewables sector to meet the increasing energy demands of the state. This project aims to identify suitable locations for wind farms and solar fields in northern Colorado. Using Census data, average air windspeed data, and land use data this project will not only examine potential sites that are available in northern Colorado for renewable energy generation, but also explore unmet energy demand among the populations in the region. Dasymetric mapping techniques will be applied to the relevant data to generate geovisualized locations of the potential sites, and feasibility assessment.

Methods:

- ❖ Land use map is used to separate public and private land and to limit where turbines and solar panels can be placed.
- ❖ Created a slope map to determine gradient. Wind turbines cannot be built on a steeper than 10% slope. Solar panels can but are optimal on more level surfaces.
- ❖ Created map of obstructions that would prevent Turbine or solar panel placement. This was narrowed down to roads and highways, lakes and streams, and airports.
- ❖ Created a wind class map which generalizes wind into categories.
- ❖ Converted all maps to rasters.
- ❖ Separated into binary, 1 for good land, and 0 for bad land.
- ❖ Calculated land types with raster calculator.
- ❖ Converted back to polygons.
- ❖ Created grids for solar and wind based on land use needs. Solar is 14.5 million meters² and wind is 33 million m².
- ❖ Picked locations based on proximity to urban centers

Research Question

What are the land use requirements for Wind and Solar energy?



Study Area:

The area of study is along Colorado's northern front range. The area includes Jackson County, Grand County, Larimer County, Boulder County, Weld County, and Morgan County. The reasons for choosing this area are it is large enough to find several good sites, the area has varying topography, population in some areas is dense but sparse in others, the land types that will be required for the sites are found within these areas, and by only using a few counties it will be easier to replicate in the future.

Conclusion:

The results of this study were more than anticipated. While the areas found are not guaranteed sites for wind and solar fields, they are great examples of future potential sites. With all the restrictions in place there were still plenty of potential sites for wind and solar to choose from. The largest restriction for wind was the land use, while the largest restriction for solar was total size. Overall, 6 sites in total were found for wind each site capable of generating 2.3 Trillion kWh of energy and 3 sites of solar were found capable of generating 1.2 Trillion kWh of energy. These numbers can be increased without changing the land size use by moving to more efficient energy collectors. The wind turbines chosen for the project were 2MW platform these are what is most common today, but the new wind turbines being made currently are capable of two to three times that with only a small increase in overall size. So, adapting the wind sits to a larger 150m wingspan from the 110m/136m decreases the number of turbines in the area to around 150,000 from the 220,000. However, the overall output of the site goes from 2.3 Trillion kWh to over 3.5 Trillion kWh.

References:

National Renewable Energy Laboratory (NREL)
Colorado Department of Transportation (CDOT)
U.S. Census Bureau
Colorado Ownership, Management and Protection service (COMaP)
National Map

